



Concepts for Change

DoD's 2014 Research and Engineering Strategy

Alan Shaffer

For more than 50 years, the Department of Defense (DoD) has relied on Research and Engineering (R&E) to provide the nation with the technology-based operational capability superiority that protects U.S. forces and helps to ensure national security. DoD's scientists and engineers work daily with industry and academia to conceive, develop and mature concepts into capabilities that provide an operational advantage to our warfighters.

The Office of the Assistant Secretary of Defense for Research and Engineering (OASD[R&E]) is responsible for the department's current and future technical and engineering capabilities and for helping to define the technical boundaries and expand the realm of the possible early in the department's acquisition process. The office includes the roles of chief technology officer, chief engineer, and chief of developmental testing, and is responsible for leading the rapid transition of new technologies to the warfighter.

Shaffer, Acting Assistant Secretary of Defense for Research and Engineering (ASD[R&E]), is responsible for formulating, planning, and reviewing the Department of Defense (DoD) Research, Development, Test, and Evaluation (RDT&E) programs, plans, strategy, priorities and execution of the DoD RDT&E budget.

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The security of our nation and the capabilities of our warfighters depend on a robust partnership of research and development (R&D) and acquisition efforts. In the past decade, examples of fielded capabilities delivered to the warfighter in part due to the efforts of the OASD(R&E) include: the first Mine Resistant Ambush Protected vehicle system, which provides dramatically greater protection for its passengers; aerostat systems that deliver 24/7 surveillance around our forward operating bases; a laser radar system that maps topography at a very high resolution and identifies objects under canopy; sensors and platforms that enable use of full-motion video in support of operational and intelligence needs; portable hybrid photovoltaic/battery systems supplying needed power at much lower weight; and wound repair and tissue regeneration capability.

Simply put, the job of the OASD(R&E) is to address the current and future needs of the DoD and its warfighters. As our warfighters move off the frontline in Iraq and Afghanistan, and the department rebalances to the Asia-Pacific region, continued investment is needed in innovative and adaptable capabilities to meet the challenges of emerging global threats.

In his foreword to the Defense Department's January 2012 strategy report, "Sustaining Global Leadership: Priorities for 21st Century Defense," President Obama wrote: "As we end today's wars and reshape our Armed Forces, we will ensure that our military is agile, flexible, and ready for the

- Mitigate new and emerging adversary threats that could degrade U.S. (and allied) capabilities.
- Affordably enable new or extended capabilities in existing military systems.
- Develop technology surprise through science and engineering applications to military problems.

These objectives complement the seven science and technology (S&T) priorities approved in 2011 by then-Secretary of Defense Robert Gates. The focus to meet these objectives is provided by the collective effort of the Services and defense agencies in cyber, electronic warfare, countering weapons of mass destruction, engineered resilient systems, autonomy, data to decisions, and human systems.

Mitigate Emerging Threats

The Defense Department must be prepared to meet its current and future missions against a backdrop of increasing types and complexities of foreign systems and capabilities. The following is an overview of threat areas and how the R&E community is addressing these challenges to maintain and advance our military's capabilities.

Cyber: We are integrating our efforts in cyber defense across the department and have prioritized our R&D investments in several focus areas: the hardening and expansion of cyber test ranges; developing metrics for cyber events; resilience under attack; improving network agility to reduce the available target; and the modeling and simulation of cyber nets.

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—President Barack Obama, January 2012

full range of contingencies. In particular, we will continue to invest in the capabilities critical to future success, including intelligence, surveillance, and reconnaissance; counterterrorism; countering weapons of mass destruction; operating in anti-access environments; and prevailing in all domains, including cyber."

Research & Engineering Objectives

The guidance is clear: The president and the secretary of defense rely on the R&E community to make key contributions to the defense of our nation. This guidance is summarized in three strategic objectives:

Advanced Electronic Warfare Systems: The proliferation and global availability of advanced digital electronics coupled with high-speed processing and advanced algorithms are enabling adversaries to develop effective countermeasures to our sensor and communications capabilities. We are working to ensure that the technology capabilities we see around the world will not undercut the effectiveness of some of our most promising and sophisticated sensors and weapons systems. The department's emphasis in countering these threats is focused on maturing and testing the next generation of electronic and photonic components as well as expanding the operating capabilities of existing and new

electronic systems, to maintain and increase our advantage in the electromagnetic spectrum.

Space: The U.S. military relies on dependable global positioning systems, communications and intelligence, surveillance and reconnaissance. A focus of our efforts is protection of these critical capabilities against emerging threats, such as

effectiveness of fielded systems and provide life-cycle costs for decision making.

The tools and procedures of ERS will produce more comprehensive and robust requirements suitable for many more alternative mission scenarios very early in the design process or pre-Milestone A. The reuse of data and models, distrib-



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electronic jammers and dazzlers, and kinetic kill vehicles, which present a challenge to future operations. We must be able to operate freely even in austere or compromised environments. The chip-scale atomic clock provides precision navigation and timing so that every dismount can know its position. We also are developing alternative communications networks that do not rely on satellites.

Affordably Enable New or Extended Capabilities

The second strategic objective emphasizes maximizing our investment dollars by improving the design and transition of technologies to acquisition programs in a more affordable and timely manner. Our focus is on both new and existing systems and their life-cycle upgrades, interoperability between existing platforms, and design and prototyping of new systems. Our Engineering Resilient Systems program, the enhanced use of prototypes, and our "Shift Left" initiative all help guide our efforts.

Engineered Resilient Systems (ERS): Our focus in ERS is to develop engineering concepts, science, and design tools to protect against malicious compromise of weapon systems and to greatly enhance the manufacturability of trusted and assured defense systems across the acquisition life cycle. Through the ERS initiative, the department is developing an integrated suite of computational modeling and simulation capabilities and systems engineering tools, complete with an open-reference architecture, directly aligned to acquisition and operational business processes. The R&D investment in ERS focuses on infrastructure, information, design support, highly robust tradespace analytics, decision support tools and knowledge environments to increase the speed and efficiency of system development, improve the

uted databases that are searched jointly, virtual collaboration environments and open architectures that encourage partnering will lead to better-informed acquisition decisions. The engineering design process is streamlined, and the manufacturability of a proposed design is explicitly investigated from both engineering and cost perspectives before design commitment. Finally, we are developing robust tools to stress systems against new mission contexts, tactics, techniques and procedures or emerging requirements, to permit precise measurement and understanding of their impact on all design and production factors.

Capability Prototyping: Operational prototyping is a flexible and robust tool we intend to use to a greater extent in evaluating new systems and technologies, stimulating design teams and exploring the realm of the possible without needing an early commitment to procurement. Capability prototyping allows us to develop and demonstrate concepts and technologies at varying degrees of maturity as a hedge against the technical uncertainty of an unanticipated threat, to enhance the interoperability or extend the utility of existing systems and to enable the introduction of more capability and affordability. It is our intent to employ capability prototyping more for subsystems and force multipliers, but we expect to do some platform prototyping as well.

Shift-Left Initiative: Affordability also can be addressed by engaging with an acquisition program earlier in the life cycle to ensure a better understanding of program technical risks and opportunities before major milestone decisions. Early systems engineering and Developmental Test and Evaluation (DT&E) will better identify and correct deficiencies, thereby avoiding the high cost of late-cycle repairs.

The Shift-Left initiative is about improving the effectiveness of DT&E, so programs can find and fix problems before entering production. Effective DT&E also requires using a robust DT&E framework to ensure a program conducts the right testing at the right time to gather the required information before milestone decisions. There are three essential elements of the initiative:

- **Mission Context:** Bringing mission context into DT&E takes the new system out of the lab to see how it will be used. It does not, however, mean program managers have to conduct developmental testing with large-scale deployment of troops to the field.
- **Interoperability:** Throughout the last decade of combat operations, we did not find interoperability issues early enough to correct them before system deployment.
- **Cybersecurity:** Ten years of data from Director of Operational Testing and Evaluation field tests assessing cybersecurity indicate that fielded systems must be protected in the cyber domain. Vulnerabilities should be discovered in testing and corrected before deployment.

Technology Surprise: Develop New Capabilities

While we will need to react, we must focus on leading change. Thus, our third strategic objective, and a critical component in the department's ability to develop new capabilities, is to invest in a wide range of potentially game-changing basic and applied research. Autonomy is one of three emphasis areas that include data to decisions and human systems priority areas, where our integrated efforts across the Services will provide new capabilities.

Autonomy Research Pilot Initiative: Autonomous technology is just one of the new capability areas that will enable technology surprise. Our activities focus on the ability to enable DoD warfighting systems to be more adaptable and more self-governing, to function with greater independence from human interaction and with reduced response times in stressed environments.

To complement our contracted research with industry and academia, we established the Autonomy Research Pilot Initiative, a new process to evaluate internal innovative ideas. This effort is a coordinated program among DoD laboratories, encouraging cross-Service collaboration by bench-level scientists and engineers on autonomy-related applied research topics.

Guided by feedback from operational experience and evolving mission requirements, seven proposals were selected out of 54 submissions to be a part of this multiyear funded activity. Advancement of technologies will result in autonomous systems that provide more capability to warfighters, lessen the cognitive load on operator/supervisors and lower overall operational cost. In addition, the investment in this cross-Service collaboration will strengthen mission effectiveness while maintaining fiscal responsibility and optimizing interoperability across all domains.

The Future: R&E's Coordinated Approach

A key strength of our R&E enterprise is its substantial emphasis on coordinated planning. Especially in these challenging budgetary times, it is important to strengthen the department's efforts to ensure that we receive the most value from our investment. As part of this coordinated approach, we have taken steps to provide new tools to communicate our efforts both internally and with industry and academia.

Horizon Scanning: To conduct effective technology horizon scanning, we are developing a low-cost effort to apply advanced analytics, leveraging a range of algorithms and data streams, to isolate and identify emerging science and technology areas.

DoDTechipedia: The ability to bring together performers and operational and acquisition communities is a challenge. DoDTechipedia (www.dtic.mil) hosts an online electronic encyclopedia and provides a platform where organizations can share information on challenges and needs.

Defense Innovation Marketplace: A critical source of innovation technology comes from outside the department. The key to this innovation source is communication, thus we deployed the Defense Innovation Marketplace (www.DefenseInnovationMarketplace.mil) to enable better connections between industry and the DoD. The Marketplace provides S&T/R&D technology needs, investment priorities and roadmaps to help industry members better support the warfighter through their independent research and development (IR&D) projects. In addition, the site contains a secure portal for industry to share its R&D projects and for DoD personnel to learn about these industry IR&D projects to better inform current and future program planning.

The DoD will always rely on R&D to provide the nation with technical superiority. Our investment over the last 50 years has enabled many breakthroughs including stealth, GPS, unmanned technology, Web protocols, advanced robotics and data mining.

As we move into this new year, with the current budget pressures and a new security landscape, we must continue to balance our investments across the department as well as with our acquisition partners. Moreover, the last two major budget contractions (post-Vietnam and the ending of the Cold War) showed that strategic efforts by the department's leadership protected R&D and allowed us to make important advances in maintaining our technological edge. The value of our research and development investments, and focus on new tools that improve affordability and communication, strengthen our overall competencies so we can continue to provide capabilities and value to the warfighter.



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